Montana Fish, Wildlife & Parks

1400 South 19th Avenue
Bozeman, MT 59718-5496

July 27, 2005

To: Governor's Office, Mike Volesky, State Capitol, Room 204, P.O. Box 200801, Helena, MT 59620-0801
Environmental Quality Council, State Capitol, Room 106, P.O. Box 201704, Helena, MT 59620-1704
Dept. of Environmental Quality, Metcalf Building, P.O. Box 200901, Helena, MT 59620-0901
Dept. of Natural Resources & Conservation, P.O. Box 201601, Helena, MT 59620-1601
Montana Fish, Wildlife & Parks:

Director's Office	Parks Division	Lands Section	FWP Commissioners
Fisheries Division	Legal Unit	Wildlife Division	Design & Construction

MT Historical Society, State Historic Preservation Office, P.O. Box 201202, Helena, MT 59620-1202
MT State Parks Association, P.O. Box 699, Billings, MT 59103
MT State Library, 1515 E. Sixth Ave., P.O. Box 201800, Helena, MT 59620
James Jensen, Montana Environmental Information Center, P.O. Box 1184, Helena, MT 59624
Janet Ellis, Montana Audubon Council, P.O. Box 595, Helena, MT 59624
George Ochenski, P.O. Box 689, Helena, MT 59624
Jerry DiMarco, P.O. Box 1571, Bozeman, MT 59771
Montana Wildlife Federation, P.O. Box 1175, Helena, MT 59624
Wayne Hurst, P.O. Box 728, Libby, MT 59923

Ladies and Gentlemen:

The enclosed Decision Notice has been prepared for the Cherry Creek Draft Supplemental Environmental Assessment (DSEA). Comments were received from six parties during the 21-day comment period running from June 30, 2005 to July 21, 2005.

It is my decision to accept the Preferred Alternative, to allow the use of rotenone in Cherry Lake, with no changes to the DSEA.

This Decision Notice is available for review from Fish, Wildlife & Parks (FWP) at the address provided above or viewed on FWP's Internet website: http://www.fwp.mt.gov/publicnotices.

Questions regarding this Decision Notice should be mailed to:

Montana Fish, Wildlife & Parks
c/o Cherry Creek Supplement
Box 1336
Ennis, MT 59729

Or by email to pclancey@mt.gov

Sincerely,

Patrick J. Flowers
Region Three Supervisor

CHERRY CREEK DRAFT SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT DECISION NOTICE

Montana Fish, Wildlife & Parks
Region Three, Bozeman
July 27, 2005

Proposal

The Draft Supplemental Environmental Assessment (DSEA) proposes to allow Montana Fish, Wildlife & Parks (FWP) the latitude to use rotenone in Cherry Lake if necessary to complete the eradication of non-native fish from the lake. Treatments in 2003 and 2004 using antimycin did not result in a complete eradication of Yellowstone cutthroat trout (YCT) in the lake as anticipated in the 1998 EA.

The goal of the Cherry Creek Native Fish Introduction Project is to introduce westslope cutthroat trout (WCT), and possibly other native fish species, into over 60 stream miles of the Cherry Creek Drainage, a tributary to the lower Madison River. To accomplish this goal competing and hybridizing nonnative fish must be removed from streams within the project area, and from Cherry Lake at the head of the drainage. Cherry Lake holds approximately 105 acre-feet of water with a maximum depth of 35 feet. Removal of the nonnative fish is accomplished using fish pesticides (piscicides) that are approved specifically for this use by the Environmental Protection Agency (EPA).

The impacts of the actions proposed in the supplement are consistent with the impacts evaluated in FWP's 1998 EA and the Montana Department of Environmental Quality 1999 EA (including evaluation of the affects of rotenone on the environment and human health), and though they were implied in those documents, the action proposed in the supplement - using rotenone in Cherry Lake - was not explicitly stated in those documents.

Montana Environmental Policy Act

Montana Fish, Wildlife & Parks is required by the Montana Environmental Policy Act (MEPA) to assess significant potential impacts of a proposed action to the human and physical environment. In compliance with MEPA, an Environmental Assessment (EA) was completed for the proposed project by FWP and released for public comment on June 30, 2005.

Public comments on the proposed project were taken for 21 days. The EA was mailed to 103 individuals, agencies, agency employees, and public groups; legal notices were printed in the *Bozeman Daily Chronicle*, the *Montana Standard*, and the *Helena Independent Record*; and the DSEA was posted on the FWP webpage: http://www.fwp.mt.gov.

Summary of Public Comment

Comments on the proposal were received from six parties.

The following issues (bold) were raised by commenting parties in the July 2005 comment period. FWP responses follow each in non-bold type:

Issue 1. Use of rotenone and its impact on water quality and non-target biota, application of piscicides over consecutive summers, impact of rotenone was not considered in the 1998 EA.

Three commentors criticized the potential use or rotenone at Cherry Lake, generally concerned about its affects on non-target organisms, or that the impacts of rotenone were not considered in the 1998 FWP EA.

The impacts of rotenone on water quality and non-target biota were analyzed in detail in the 1998 EA and in the 2005 supplement.

In the 1998 EA, beginning on page 15, impacts to water quality are detailed - "*A principal element of the proposed project is to introduce … rotenone at a concentration of 0.25 to 1.0 parts per million….*

… this will be only a minor impact on the water quality for several reasons. Concentrations … will be very low, rotenone in the parts per million…. These chemicals will be introduced into the water for short periods of time, about one to five days per year for three to five years. Apart from their intended toxic effect on fish, the chemicals are relatively benign in the environment."

And on page 21 of the 1998 EA, impacts on non-target biota are addressed – "*In general, most studies report that aquatic invertebrates, except zooplankton are much less sensitive to rotenone treatment than fish (Schnick 1974b). One study reported that no significant reduction in aquatic invertebrates was observed due to the effects of rotenone, which was applied at levels twice as high as the levels proposed for this project (Houf and Campbell 1977). In all cases the reduction of aquatic invertebrates was temporary, and most treatments used a higher concentration of rotenone than proposed for this project (Schnick 1974b). In a study on the relative tolerance of different types of aquatic invertebrates to rotenone, Engstrom-Heg et al. (1978), reported that the long-term impacts of rotenone are mitigated because those insects that were most sensitive to rotenone also tended to have the highest rate of recolonization. The authors of this study also suggest that it is probable that in most streams, only mild and temporary damage to aquatic invertebrates would occur in treatments using rotenone at levels ten times higher than the levels proposed for this project.*

Because of their short life cycles (Anderson and Wallace 1984), good dispersal ability (Pennack 1989) and generally high reproductive potential (Anderson and Wallace 1984), aquatic invertebrates are capable of rapid recovery from disturbance (Jacobi and Deegan 1977; Boulton et al. 1992; Johnson and Vaughn 1995; Matthaei et al. 1996; Nelson and Roline 1996). Moreover, since many headwater reaches of tributaries in the Cherry Creek drainage basin have no fish (Table 2), they will not be treated with fish toxicants. Therefore, these headwater areas will be available to serve as sources of aquatic invertebrates for recolonization into treated areas."

In the FWP July 6, 1998 Decision Notice for the Cherry Creek Native Fish Introduction Project, it is stated beginning on page 6 – "*Some aquatic invertebrates have shown short-term decreases in density after fish eradication treatments, but have recovered to pre-treatment densities within seven months after treatment. In most cases, reduced invertebrate densities were a result of exposure to higher concentrations of toxicants than will be used in this project (pages 6, 21, 56 of the EA). As documented in the EA (pages 6,*

21-23), plants, adult amphibians, reptiles, birds, and mammals are not affected by the concentrations of antimycin or rotenone that will be applied during this project. Additionally, few, if any, non-target organisms, such as amphibians, will be in life stages sensitive to antimycin or rotenone during the application period in August.

The June 30, 2005 Supplemental EA presents results of monitoring efforts on aquatic invertebrates and bioassays on juvenile and adult stages of both spotted frogs and boreal toads.

Both rotenone and antimycin are short-lived, persisting for a matter of weeks at most. Neither rotenone nor antimycin persist in non-target organisms for long periods, so cumulative effects are unlikely.

Two commentors felt the use of rotenone in Cherry Lake is justified and was thoroughly analyzed in the 1998 FWP EA. Both felt similar projects should be conducted at other locations to restore WCT populations.

One commentor stated "the project continues to fit within the framework and objectives" of the Memorandum of Understanding and Conservation Agreement for Westslope Cutthroat Trout in Montana which describes Montana's approach to WCT conservation and restoration. This commentor also stated "…the only genuine risk with this project is that it might not completely work. That's a small, and fairly inconsequential worry compared to the significant benefits that will result from a successful project."

Issue 2. Human health affects of rotenone, specifically as a cause of Parkinson's Disease.

One commentor stated that "Rotenone as a toxic poison to humans was reported in Nature Neuroscience as "a cause for Parkinson's disease …."

The 1998 FWP EA, the 1999 DEQ EA, and the 2005 FWP Supplemental EA all thoroughly address human health concerns associated with rotenone.

The following paragraphs address a study concerning rotenone and Parkinson's Disease (information available at http://www.fisheries.org/html/rotenone/parkinsonstudy.shtml):

Parkinson's Disease

Parkinson's disease results in a lost function of the brain cells that produce dopamine, used to transmit signals in the brain. Symptoms of the disease usually include limb tremors and occasional rigidity. The causes of Parkinson's disease are diverse and complex. Some cases can be attributed to genetic factors, and several mutations have lead to familial Parkinson's disease (Giasson and Lee 2000).

Summary of Emory University Study

Emory University (Atlanta, Georgia) conducted a study that demonstrated that rotenone produced Parkinson's-like anatomical, neurochemical, and behavioral symptoms in laboratory rats when administered chronically and intravenously (Betarbet et al. 2000). In this study, 25 rats were continuously exposed for 5 weeks to ~3 mg rotenone (dissolved in dimethyl sulfoxide [DMSO] and polyethylene glycol [PEG]) per kg body weight per day. The exposure was accomplished by injecting the mixture directly into the right

jugular vein of the rats using an osmotic pump. Twelve of the 25 rats developed lesions characteristic of Parkinson's disease. Structures similar to Lewy bodies (microscopic protein deposits) in the neurons of the substantia nigra in the brain (characteristic of Parkinson's disease) were produced in several of the rotenone-exposed rats.

Method of Exposure Limits the Usefulness of Emory University Study to Establish Relationship between Rotenone Use in Fisheries Management and Parkinson's Disease

The manner that rotenone was administered to the laboratory rats was highly unnatural. Not only was it administered by continuous jugular vein infusion, it was mixed with DMSO and PEG. DMSO enhances tissue penetration of many chemicals (Dr. Peter Kurtz, M.D., California Department of Food and Agriculture, personal communication). The normal exposure to rotenone in humans from its use in fisheries management would be ingestion, inhalation or through the skin. Direct injection is the fastest way to deliver chemicals to the body, as evidenced in intravenous application of medicines. Continuous intravenous injection, as done in this study, also leads to continuously high levels of the chemical in the bloodstream. Normal ingestion, inhalation, and dermal exposures significantly slow down the introduction of chemicals into the bloodstream. Administering any chemical directly into living tissues can have grave consequences. For example, sodium chloride (table salt) administered to developing chick embryos causes birth defects (Dr. P. Kurtz, M.D., California Department of Food and Agriculture, personal communication). However, this model has no practical predictive value for humans ingesting salt. Similarly, penicillin injected into the brain of cats induces seizures, but this does not suggest that ingestion will cause similar effects in humans.

Likewise, the method of exposure in the Emory University study cannot be used as a model for any form of rotenone exposure in fisheries management. Rotenone exposure in the environment is extremely limited. Rotenone is very unstable in the environment (half-life measured in days), is oxidized (neutralized) through enzymatic action in the gut of mammals and birds, is metabolized to very polar (water soluble) compounds in the body, and these compounds are excreted by the liver and kidney (Finlayson et al. 2000). Because of the rapid metabolism and clearance in mammals and birds, it is not likely that rotenone could reach the site of action in the substantia nigra in the brain where the dopamine is formed. Rotenone is toxic to fish because it is taken up rapidly across the gills and gets directly into the bloodstream, thus, bypassing the gut. Rotenone is considered safe for the environment because it loses all its toxicity in a few days. In fact, it is significant that the Emory University investigators could not administer rotenone in any other manner except intravenously and get delivery of rotenone to the brain; otherwise, rotenone would have been neutralized in the gut and liver.

Exposure to applicators applying rotenone in fisheries management is further minimized through the use of protective equipment such as air-purifying respirators, protective clothing (coveralls, gloves), and eye protection (splash goggles or face shields) that are required on the product labels (Finlayson et al. 2000). Specific information on proper handling procedures and protective equipment are found on rotenone labels.

The results from a chronic feeding study with rats using rotenone found no Parkinson's-like anatomical or behavioral symptoms (Marking 1988). In this 24-month chronic feeding study, rotenone was orally administered to 320 rats in doses up to 75 mg/kg per day. All surviving animals were sacrificed and tissues and organs of all test animals were examined macroscopically and microscopically. The brain was sectioned, and

microscopic examinations of the basal ganglia, frontal cortex, occipital cortex, thalamus, and cerebellum were completed. No changes were observed in the brain of these rotenone-exposed rats. It is significant that these rats were exposed to up 30 times more rotenone (2.5 versus 75 mg/kg/d) for 21 times longer (5 versus 104 weeks) than the rats used in the Emory University study. However, these rats were exposed to rotenone by ingestion, the route people would be exposed to rotenone.

What is the Value of the Emory University Study?

Several researchers in Parkinson's disease (including J. Langston, Director of the Parkinson's Institute) have stated that the study is not direct evidence that rotenone causes Parkinson's disease. The U.S. Environmental Protection Agency has known for some time of the effects of rotenone on the nervous system when injected directly into animals. In 1993, the U.S. Environmental Protection Agency published the Worker Protection Standard Handbook that listed all the known effects of pesticides and necessary steps for treating pesticide poisoning (Pesticide Regulation Notice 93-7). In the Biologicals section of the handbook the following statement is made, "When rotenone has been injected into animals, tremors, vomiting, incoordination, convulsions, and respiratory arrest have been observed. These effects have not been reported in occupationally exposed humans." Thus, the effects of rotenone injected directly into animals were known before the study done at Emory University. The true value of the study is in developing a model of Parkinson's disease so researchers will have a better method to study the cellular defects associated with Parkinson's disease, not in discovering the cause(s) of Parkinson's disease.

Issue 3. Failure to comply with state and federal laws and policies, specifically the Wilderness Act, the federal Data Quality Act, Montana statutes and FWP's Wild Fish Policy.

One commentor stated that the Forest Service "…forgot and circumvented the laws ….", and "FWP has forgotten the longstanding (F&G) policy of no artificial fish introductions into Montana streams and rivers….", and "This action on public state land violates the MEPA and MCA statutes."

On page 9 of FWP's 1998 EA, it is stated - "*U.S. Forest Service Policy and Guidelines For Management Of Fish And Wildlife Within Wilderness Areas:*

Policy*: Chemical treatment may be necessary to prepare waters for reestablishment of native species, to reestablish an endangered or threatened species, and to correct undesirable conditions resulting from the influence of humans.*"

Project opponents have pursued administrative challenges and lawsuits in both state and federal courts, claiming the use of fish toxicants violates state and federal water quality laws. In all instances, no violation of state or federal rules, regulations, or laws has been found, including the Water Quality Act, Data Quality Act, Wilderness Act, or any Montana statutes.

On page 17 of the 1998 FWP Decision Notice, it is stated – "*FWP is firmly committed to perpetuating and implementing its Wild Fish Policy. This is clearly stated on page 2 of the Draft Fisheries Beyond 2000 document, under the heading "Mission of the Fisheries Program". We do reserve the right to use hatchery reared wild stocks of fish in efforts to*

restore native fish species. We have used these sources in other westslope cutthroat restoration efforts"

Issue 4. Comments relative to the status of and relationship between westslope cutthroat trout and Yellowstone cutthroat trout (cutthroat subspecies, historic relationships, genetic integrity, population status, anticipated failure of 'hatchery' WCT introductions in Cherry Creek Drainage).

Both WCT and YCT are candidates for listing under the Endangered Species Act (ESA), but neither is currently listed.

Two commentors raised the point that YCT are imperiled in Yellowstone Lake and implied the removal of YCT from Cherry Lake is counterproductive, or mistakenly thought that WCT occupy Yellowstone Lake and are soon going to be extinct there. The status of YCT in Yellowstone Lake is not relevant to the Cherry Creek Project. The ESA recognizes actions taken in the historic range of a listed species, so maintaining a YCT population anywhere outside of the Yellowstone River Drainage would not 'count' toward the status of YCT. And again, YCT are not listed under the ESA.

One commenter cited Wyoming Fishes (Baxter & Simon 1970), stating that there are over 16 subspecies of YCT, 12 of which are recognized in Wyoming, and that they have mixed with other varieties in most of the drainages in the western United States. Wyoming Fishes has been updated and superseded by the Fishes of Wyoming (Baxter & Stone 1995). The Fishes of Wyoming states there are 5 subspecies of cutthroat in Wyoming, including YCT and WCT. The YCT is only one of 14 known cutthroat subspecies, 12 of which exist today. Fishes of Wyoming cites Behnke (1992) in stating that 6 "minor" subspecies of cutthroat descended from the YCT millenia ago, but the WCT is not one of them. Behnke (1992) states that YCT and WCT are evolutionarily the most divergent of all cutthroat subspecies. Additionally, WCT have 66 chromosomes while YCT have 64.

As stated on page 12 of FWP's 1998 Decision Notice – "*Some commentors believe that Yellowstone cutthroat trout, not the westslope cutthroat, are native to the eastslope (Missouri River Drainage), or that westslope cutthroat is a misnomer for those fish native to the Missouri Drainage. Contrary to these beliefs, Yellowstone cutthroat are native only to the Yellowstone River Drainage. It may be somewhat of a misnomer to call cutthroats native to the Missouri Drainage westslopes, but through genetic analyses and meristic characteristics, Missouri Drainage cutthroat trout have been determined to be the same subspecies as those in Montana west of the continental divide, and in parts of Idaho, Oregon, Washington, British Columbia, and Alberta.*"

On pages 7 & 8 of the 1998 FWP EA, the WCT introduction strategy is detailed – "*Cherry Creek offers an opportunity to evaluate two different donor source strategies for the restoration of westslope cutthroat trout. One strategy is to use a wild donor stock which is a "nearest neighbor". The rationale behind this strategy is that local adaptation may give this stock of fish a selective advantage in a nearby geographic location. Another advantage of this approach is that an existing genetically unique population will be replicated in the wild. The risk of this strategy is that the donor source may be very narrowly adapted to a specific environment and might not survive well in another environment. This strategy is often termed the specialist strategy. The other strategy is to use a donor source with as broad a genetic makeup as possible. The rationale behind this strategy is that while many individuals originating from this donor source will likely*

perish, there will be a component that is highly suitable for any particular environment. This strategy is often termed the generalist strategy.

Fertilized eggs from the Washoe Park Fish Hatchery in Anaconda (a generalist) as well as fertilized eggs from a wild stock inhabiting one or more tributaries to the Madison River (a specialist) will be used for the introduction of westslope cutthroat trout to the upper Cherry Creek drainage basin. Graduate research projects at Montana State University will identify genetic markers from these two donor stocks of westslope cutthroat trout. Sampling of the introduced westslope cutthroat trout will be done two years, five years, and ten years following the initial releases of fertilized eggs. The proportion of the population from each donor source will be determined which will allow an evaluation of the relative success of each stock. This technique of genetic sampling can be done by clipping a small portion of a fin and will not require sacrificing any fish."

On page 17 of the 1998 FWP Decision Notice, the issue of using 'hatchery' fish is addressed – "*Several commentors questioned the strategy of using westslope cutthroat from the Washoe Park Hatchery in Anaconda due to their composite genetic make-up from wild populations west of the continental divide, or suggested we avoid use of "hatchery" fish altogether. The University of Montana Genetics Lab conducted analyses and comparisons of the genetic material of pure westslope populations across the state- 113 populations from the Missouri Drainage, 316 from the Clark Fork Drainage, 148 from the Flathead drainage, and 31 from the Kootenai Drainage. Their analyses revealed that 65% of the overall genetic variation of pure westslope cutthroat was due to variation within populations, 34% due to variation among populations within a drainage, and only 1% due to variation between the Missouri and Columbia drainages. These results indicate that WCT populations can be genetically very different from each other, even over short geographic distances.*"

In 2001, FWP and the Sun Ranch, LLC, developed and implemented a Memorandum of Understanding that allows the two groups to work together to develop a genetic generalist for the upper Missouri River Basin, and to propagate WCT from individual streams for introduction to recipient streams such as Cherry Creek and Cherry Lake. In this program, eggs are collected from wild genetically pure WCT populations and incubated in the Sun Ranch Hatchery. From each donor stream, some eggs will be hatched out and the fry stocked into the Sun Ranch pond to contribute to the upper Missouri generalist, but most eggs will be outplanted into recipient streams to replicate the donor stream population.

One commentor stated that the 1971 book by C.J.D. Brown, entitled Fishes of Montana does not mention westslope cutthroat trout, implying that the WCT is not a recognized species. Both WCT and YCT are described beginning on page 53.

Issue 5. Impacts of project activities on the drainage (road & trail use, weed prolifiraiton, solitude)

One commentor raised concerns regarding the possible impact of conducting the project on roads and trails, weed control, and the quietness of the area. Project personnel are using existing roads and trails to access the project area – the same roads and trails that are used and maintained by other agencies, both state and federal, as well as livestock permitees, outfitters and guides, and the general public. Project personnel are in the area approximately 4 –5 weeks each year.

Project vehicles, including the undercarriage, are inspected for vegetation and washed prior to access the Flying D Ranch and the public lands in the project area to reduce or eliminate the possibility of introducing and/or spreading weeds. This issue is addressed on page 19 of the 1998 FWP EA.

Few recreationists have been encountered by project personnel in the project area either during preparatory work or during actual chemical application in previous years. Most encounters are with livestock permitees or federal agency personnel conducting activities associated with their management responsibilities.

Issue 6. Affect of the project on the cost of hunting and fishing license, partnership with a private organization, better use of the money for habitat projects, waste of FWP money.

Four commentors criticized the partnership between FWP, the U.S. Forest Service, and Turner Enterprises, Inc., to conduct this project and the financial contribution of TEI to the project.

One commentor wanted to know where the money for the project was coming from, and asked if this project is one of the reasons for the recent increase in hunting and fishing fees.

An estimated budget was provided in the 1998 FWP Decision Notice detailing the source of funds for the project.

In 2001, prior to the 2003 implementation of the project, FWP decided not to spend any state money on the project, but to rely on volunteer efforts and contract money to conduct the project. FWP has not spent any state (hunting or fishing license) money on the project, and will not do so. The project has not affected and will not affect the cost of a hunting or fishing license.

Since approximately 70 percent of the cost of the project is being funded privately, that money might not otherwise be available to public agencies for habitat restoration.

Issue 7. Project time frame

One commentor did not recall that the project, as planned, would be conducted for more than two years. On page 8 of the 1998 FWP EA, it is stated, "*The overall project is expected to last at least five years. The eradication process will proceed in stages beginning in August 1998 and will take a minimum of three or four years, beginning in the farthest upstream reaches, and progressing downstream.*", and on page 16, "*These chemicals will be introduced into the water for short periods of time, about one to five days per year for three to five years.*" Because of challenges to the project, including litigation in state and federal courts, the project was not implemented until 2003.

Issue 8. Build a barrier to prevent the fish in the lake from leaving it.

One commentor wondered why a barrier could not be constructed that would prevent the fish from leaving the lake.

While it may be possible to construct a downstream barrier to prevent fish from moving downstream out of the lake, the logistics of doing so in a remote location and the long-term impacts to the character of the Wilderness prevent it. Such a barrier would have to be built to last into perpetuity and be able to remain functional under a variety of runoff conditions, especially at unusually high flows. Without routine maintenance, such a structure would eventually fail, allowing any non-native fish remaining in Cherry Lake access to the downstream portion of the project area.

Final Supplemental Environmental Assessment for the use or rotenone in Cherry Lake

There are no modifications necessary to the Draft Supplemental Environmental Assessment based on public comment. The Draft Supplemental Environmental Assessment, together with this Decision Notice, will serve as the final document for this proposal.

Decision

Based on the Draft Supplemental Environmental Assessment and considering the public comment received, it is my decision to select the Preferred Alternative, to allow the use of rotenone in Cherry Lake, if necessary to complete the eradication of non-native fish. I find there to be no significant impacts on the human and physical environments associated with this project. Therefore, I conclude that the Supplemental Environmental Assessment is the appropriate level of analysis, and that an Environmental Impact Statement is not required.

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Patrick J. Flowers
Region Three Supervisor

Literature Cited

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